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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/791,904	03/04/2004	Darrell M. Erb	50432-614	4666

7590 04/21/2005

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EXAMINER	
SANDVIK, BENJAMIN P	

ART UNIT	PAPER NUMBER
2826	

DATE MAILED: 04/21/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/791,904	ERB ET AL.	
	Examiner	Art Unit	
	Ben P. Sandvik	2826	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-19 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-19 is/are rejected.

7)☒ Claim(s) 8,9 is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Objections

Claim 8 is objected to because of the following informalities: the limitation "the method comprising..." has no antecedent basis. Appropriate correction is required.

Claim 9 is objected to because of the following informalities: its depending claim (claim 8) is not a method claim. Appropriate correction is required.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1 and 10 are rejected under 35 U.S.C. 102(b) as being anticipated by Nogami et al (U.S. Patent #6346745), hereafter known as Nogami.

With respect to **claims 1 and 10**, Nogami teaches a first dielectric layer over a substrate (Fig. 1, 12), a copper interconnect inlaid in the first dielectric layer (Fig. 1, 10 and Col 6 Ln 5-11), a composite capping layer on the inlaid copper interconnect comprising a layer of beta-tantalum on an upper surface of the inlaid copper (Fig. 1, 13 and Col 5 Ln 61), a layer of tantalum nitride on the

layer of beta-Ta (Fig. 1, 14 and Col 5 Ln 64), and a layer of alpha-Ta on the layer of TaN (Fig. 1, 16 and Col 6 Ln 2).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 4 and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nogami.

With respect to **claims 4 and 14**, Nogami discloses the claimed invention except for the exact thickness of the alpha-Ta layer being 200-500 angstroms, but it is taught by Nogami to be 10-150 angstroms. The applicant's disclosure does not specify the critical element of the range, since such a modification would have involved a mere change in the size of a component. A change in size is generally recognized as being within the level of ordinary skill in the art. *In re Rose, 105 USPQ 237 (CCPA 1955).* It would have been obvious to change the size of the alpha-Ta layer in Nogami to be between 200-500 angstroms in order to make the capping layer fit into the recess of the copper inlay.

Claims 2, 3, 5, 11, 12, and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nogami, in view of Wang et al (U.S. Patent #6207552).

With respect to **claims 2 and 11**, Nogami teaches all of the limitations of claim 1, but does not teach that the composite capping layer is formed in a recess in the inlaid copper interconnect such that an upper surface of the alpha-Ta layer is substantially coplanar with an upper surface of the first dielectric layer. Wang teaches a capping layer formed in a recess in the copper interconnect (Fig. 5, 220) such that the upper surface of the capping layer is substantially coplanar with an upper surface of the dielectric layer (Fig. 7, 230). It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the capping layer of Nogami in a recess in the copper interconnect as taught by Wang in order to create a strong interface.

With respect to **claims 3 and 13**, Nogami discloses the claimed invention except for the exact thickness of the alpha-Ta layer being 200-500 angstroms, but it is taught by Nogami to be 10-150 angstroms. The applicant's disclosure does not specify the critical element of the range, since such a modification would have involved a mere change in the size of a component. A change in size is generally recognized as being within the level of ordinary skill in the art. *In re Rose, 105 USPQ 237 (CCPA 1955).* It would have been obvious to change the size of the alpha-Ta layer in Nogami to be between 200-500 angstroms in order to make the capping layer fit into the recess of the copper inlay.

With respect to **claims 5 and 12**, Nogami teaches all of the limitations of claim 3, but does not teach a diffusion barrier lining and opening in the first dielectric layer and the copper interconnect on the diffusion barrier filling the opening. Wang teaches a diffusion barrier lining and opening in the first dielectric layer and the copper interconnect on the diffusion barrier filling the opening (Fig. 5, 210). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have a diffusion barrier around the copper interconnect in Nogami as taught by Wang in order to prevent copper from diffusing into the dielectric layer.

Claims 6-9 and 16-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nogami and Wang, further in view of Schmidbauer et al (U.S. Patent #6221757).

With respect to **claims 6-8 and 16-18**, Nogami and Wang teach all of the limitations of claim 3 and a dual damascene opening that is filled with copper to form an interconnect comprising a lower via in contact with an upper line (Nogami: Col 3 Ln 30 and Col 3 Ln 42), but do not teach a second dielectric layer over the first dielectric layer and a copper interconnect inlaid in an opening in the second dielectric layer in electrical contact with the surface of the alpha-Ta layer or an alpha-Ta diffusion barrier lining the opening in the second dielectric layer. Schmidbauer teaches a second dielectric layer (Fig. 4, 5) over the first dielectric layer and a copper interconnect (Fig. 4, 75) inlaid in an opening in the second dielectric layer in electric contact with the upper surface of the alpha-Ta

layer (Fig. 4, 20), and an alpha-Ta diffusion barrier lining the opening in the second dielectric layer (Fig. 4, 50). It would have been obvious to one of ordinary skill in the art at the time the invention was made to make the device of Nogami with a copper inlay in contact with the upper surface of the alpha-Ta, a second dielectric layer, and an alpha-Ta diffusion barrier in order to reduce electromigration, simplify the fabrication process, and to prevent the diffusion of copper into the dielectric layer, respectively.

With respect to **claims 9 and 19,** Nogami, Wang, and Schmidbauer disclose the claimed invention except for a composite capping layer on the copper inlay in the second dielectric layer comprising a layer of beta-tantalum on an upper surface of the inlaid copper, a layer of tantalum nitride on the layer of beta-Ta, and a layer of alpha-Ta on the layer of TaN. It has been held that mere duplication of the essential working parts of a device involves only routine skill in the art. *St. Regis Paper Co. v. Bemis Co., 193 USPQ 8.* It would have been obvious to place an identical capping layer on the second copper inlay so that electromigration and stress migration can be reduce in subsequent layers.

Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nogami and Wang, in view of Lopatin et al (U.S. Patent #6096648).

With respect to **claim 15**, Nogami and Wang teach all of the limitations of claim 11, but do not teach that the beta-Ta, tantalum nitride, and alpha-Ta layers are deposited by physical vapor deposition. Lopatin teaches that tantalum can

be deposited by physical vapor deposition (Col 4 Ln 18-22). It would have been obvious to one of ordinary skill in the art at the time the invention was made to deposit the tantalum layers using PVD as taught by Lopatin in order in to use a clean, dry vacuum deposition process.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ben P. Sandvik whose telephone number is (571) 272-8446. The examiner can normally be reached on M-F.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nathan Flynn can be reached on (571) 272-1915. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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